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THE GEOLOGY OF THE

COUNTRY AROUND ATTLEBOROUGH, WATTON, AND WYMONDHAM.

(EXPLANATION OF QUARTER-SHEET 66 S.W.)

BY

F. J. BENNETT, F.G.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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ENGLAND AND WALES.

THE GEOLOGY OF THE COUNTRY AROUND ATTLEBOROUGH, WATTON, AND WYMONDHAM.

(EXPLANATION OF QUARTER-SHEET 66 S.W.)

BY

F. J. BENNETT, F.G.S.

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ARCH. GEIKIE,
Director-General.

Geological Survey Office,
London,
November 1884.

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ARCH. GEIKIE,
Director-General.

Geological Survey Office,
London,
November 1884.

NOTICE.

The area embraced within the Map here described lies entirely within the County of Norfolk, and was surveyed, during the years 1881-83, by Mr. F. J. Bennett, under the superintendence of Mr. H. B. Woodward. The fossils obtained from the Chalk have been named by Messrs. G. Sharman and E. T. Newton.

Only one Edition of this Map is published—that showing the Superficial deposits.

A full account of the geological literature of the County is given in the Geological Survey Memoir "On the Geology of the Country around Norwich," 1881.

H. W. Bristow,
Senior Director.

Geological Survey Office,
28, Jermyn Street, London, S.W.,
November 1884.

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THE GEOLOGY

OF THE

COUNTRY AROUND ATTLEBOROUGH, WATTON, AND WYMONDHAM.

INTRODUCTION.

Area.—The tract to be described embraces an area of about 205 square miles in the southern part of Norfolk, and includes the towns of Attleborough, Wymondham, Watton, Hingham, and East Harling.

Rivers.—The river Thet, which rises at Besthorpe, in the Decoy Common, drains nearly the whole of the southern half of the district, and a portion of the northern half, in a course of about 10 miles; and from Harling to Bridgeham (where it leaves the area) it becomes a fairly broad stream.

On the north it receives small tributaries from Great Ellingham, Rockland All Saints, and Stow Breckles; on the west it receives tributaries from Breckles Heath, East Wretham, and Roudham Car; on the east it receives tributaries from near Besthorpe, Old Buckenham fen, and New Buckenham; and on the south it receives a tributary from Kenninghall and Quiddenham.

The north-west corner of the district is drained by two streams, both of which join the Wissey in the area of Sheet 65. One rises at Scoulton Mere, then flows west to Watton and Threxton, and leaves the area one mile and a quarter north-west of Threxton; the other rises at Merton, flows south to Thompson, then west to Tottington and Sturston, where it leaves the area. The tract comprised in the north-eastern corner of the map is drained by the Tiffey at Wymondham, rising three miles to the south-east of that town, with a tributary at Ashwell Thorpe and Wattlefield, called the Bays River; by another one at Wicklewood, called the Dyke Beck; and a third stream which, rising at Sea-Mere, near Hingham, and flowing by Hackford and Crownthorpe, runs into the Kimberly Lake by Falstaff Wood. The Tiffey expands into the lake and joins the Yare at Barford, in the adjoining area of Sheet 66 N.W.

The south-east corner of the area is drained by a stream which rises at Bunwell, Carlton Rode, and Tibbenham, and leaves the district just north of Aslacton.

Formations.—Were the Drift not shown on this map, the whole area would be coloured as Chalk; but this formation is only to be seen to the west and south, where the Thet has cut through the overlying drift deposits, and in a small inlier of Chalk which occurs north-west of Watton.

The extreme irregularity in the occurrence of the Boulder Clay and gravel has made the mapping of them a matter of great difficulty; and this has been much increased by the wide-spread covering of sand which obscures the beds in the western part of the area.

The following column shows the various strata met with in this district:—

Recent and Post Glacial.	Alluvial Deposits	Alluvium. River Gravel.
Glacial Drift	- - - -	Boulder Clay. Gravel and sand. Brickearth.
Cretaceous	- - - -	Chalk.

Towns.—Wymondham stands on the top and on the slope of a sharp rise, composed of the coarse gravel which generally rests on Boulder Clay.

Attleborough stands on gently rising ground, capped with gravel resting on Boulder Clay. The gravel is very variable in thickness, and was at one time worked north of the town; its greatest depth seems to have been 10 feet. Owing to the irregular thickness of the gravel and to its clay base, the water supply is in some cases contaminated with the sewage. After a continued rainfall many of the cellars in the houses are filled with water. The gravel on the south-west of the town ends against Boulder Clay.

Hingham stands on rising ground, composed of Boulder Clay, with a loamy top in places. As far as I could judge, the water supply must come from the clay, or from seams of gravel and sand in it, as I have not been able to find any superficial covering of gravel.

Watton stands wholly on Boulder Clay of no great thickness, as the wells seem to be sunk through it to the Chalk beneath. New Buckenham seems also to stand partly on a patch of gravel over Boulder Clay and partly on Boulder Clay.

Kenninghall stands partly on gravel over Chalk, partly on Chalk, and partly on Boulder Clay.

Banham stands on high ground and mostly on loam overlying Chalk; a portion of the town is on Boulder Clay.

East Harling is situated partly on Chalk and partly on gravel.

CHALK.

The exposure of the Chalk in this area is almost entirely confined to its south-western portion. In no instance does it come to the surface entirely free from any superficial covering, as it occurs near the surface, just where the sand-covering predominates.* These small Chalk areas may be grouped according to the valleys in which they occur. The Chalk of Saham Tony is grouped with the "Medial Chalk" of Samuel Woodward.

1.—*Valley of the Wissey.*

One mile W.S.W. of Saham Tony Church a lime-kiln, marked on the map, shows 25 feet of thin-bedded chalk with lines of nodular flints; half a mile east of this is another pit, now much grown over, but evidently once worked for chalk. The Chalk here contains *Micraster coranguinum*, and fragments of *Inoceramus*.

At Lime-Kiln Farm, half a mile west of the former kiln, and 1½ miles west of Saham Tony Church (also marked on the map), is another very large pit, which is still worked for lime, the former pit being now abandoned. It shows 35 feet of soft thick-bedded chalk, with bands of nodular flint.

The following fossils were obtained by Mr. J. Rhodes, the Fossil-Collector of the Geological Survey:—

Inoceramus Lamarckii, *Park.*
„ involutus, *Sow.*
„ (fragments).
Pecten nitidus, *Mant.*
Spondylus.

In the museum of the Geological Society of London is a specimen of *Ptychodus mammillaris*, Ag., from the same locality.†

2.—*Western Tributary Valley of Thet.*

In the Tributary valley in which Wretham Park is situated, there are a few Chalk pits.

About half a mile north-east of the Hall is a pit that has been rather largely worked, showing 15 feet of soft rubbly Chalk. Another one, half a mile north-west of the Hall (marked on the map as a lime-kiln), shows rubbly Chalk burnt for lime. There is also another pit a quarter of a mile due west of the Hall.

The railway-cutting south of Wretham Station also shows soft rubbly Chalk. The valley east of East Wretham is in Chalk all the way to the junction with the main stream.

Half a mile south-west of Shropham Church, and a quarter of a mile north of Brad Car Hall Farm, is a large pit showing 20 feet of soft Chalk, capped by Boulder Clay &c., with pipes of sand.

The valley in which the sheets of water called Langmere and Round Mere are situated is in Chalk, but it shows no sections worthy of mention.

---

* For a description of this sand, *see* p. 15.

† *See also* S. Woodward, Geology of Norfolk, p. 50; and C. B. Rose, Proc. Geol. Assoc., vol. i., p. 226.

3. *Valley of the Thet.*

One mile and a quarter east of Harling Road Station, a little due east of Overy Farm, and close by the side of the road leading to that farm from off the main road, is a pit in Boulder Clay with Chalk shown at the bottom.

One quarter of a mile north-west of Bridgeham Church is a large pit, showing 20 feet of thin-bedded soft Chalk with a few flints. Here Mr. Rhodes obtained the following species of fossils:—

Ventriculites.
Cidaris hirudo, *Sorignet.*
„ (spines and plates).
Rhynchonella plicatilis, *Sow.*
Ostrea, sp.
Spondylus, sp.
Belemnitella, sp.

South of the turnpike road to Thetford, and just before this leaves the map in the south corner of the area, is a pit showing soft rubbly Chalk about 12 feet deep. At this pit Mr. Rhodes procured specimens of *Spongia*, *Cidaris perornata*, Forbes, *Cidaris* (plates), and *Inoceramus.*

4. *Eastern Tributary Valley of the Thet.*

In the valley in which Banham and Quiddenham are situated, there are Chalk pits, some of which are worked for lime.

One mile west-south-west of Banham Church, and west of the road, is a pit showing 15 feet of soft rubbly Chalk with flints. Here Mr. Rhodes obtained the following species of fossils:—

Echinocorys vulgaris, *Breynius* (= Ananchytes ovatus, *Leske*).
Cidaris (spine).
Rhynchonella Martini, *Mant.*
Inoceramus (fragment).
Ostrea vesicularis, *Lam.*
„ acutirostris, *Nilss.*
„ sp.
Belemnitella quadrata, *Defrance.*
„ sp.
Fish scales.

One mile east of Harling Church is a lime-kiln, marked on the map, showing 20 feet of soft thin-bedded Chalk with tabular and nodular flints.

Here the following species of fossils were obtained by Mr. Rhodes:—

Ventriculites, sp.
Rhynchonella Cuvieri, *D'Orb.*
Inoceramus (fragment).
Ostrea acutirostris, *Nilss.*

GLACIAL DRIFT.

The surface of this district is almost entirely composed of Glacial Drift, and chiefly of one division of it, namely, the Boulder Clay.

It does not seem at all possible in this area to separate the Glacial Drift into Upper, Middle, and Lower Glacial divisions.*

The following are the beds met with :—

		FEET.
Glacial Beds.	4. Coarse "cannon-shot" gravel and sand	up to 25
	3. Boulder Clay	„ to 90
	2. Brickearth or Loam	„ to 15
	1. Sand and gravel.	

The entire succession of these beds is never seen in this area; the most complete is one (partly obscured now, but seen clear by Mr. H. B. Woodward in 1876), in the new road-cutting by the Wymondham Station (*see* page 14). There, coarse cannon-shot gravel overlaid sand, with a thin bed of Boulder Clay in places; then more Boulder Clay, with patches of purple and brown clay on it, underlaid the sand; then below there was sand again. At one place in the new line from Wymondham to Forncett a small patch of Boulder Clay was seen resting on the coarse gravel. (*See* page 15.)

So tumultuous, from the very nature of things, must have been the beds resulting from glacial action, and so dependent on the varying nature of the ground over which either the ice or the water passed, that it would be strange to find any continuous order in the deposits formed during this time of constantly changing conditions. The simplest and most reasonable plan seems to be to group them all as Glacial beds, making no distinction in age between one deposit on Boulder Clay and one beneath it. Indeed, the beds shown in the grand cliff-sections near Cromer exhibit far more signs of disorder than order, as Mr. Reid's most instructive Section of the coast fully illustrates.†

1. *Sand and Gravel.*—Of the so-called "Middle Glacial" beds we have no instances, unless we identify them in the road-cutting by Wymondham Station. The sand touched in many of the wells below the Boulder Clay might be classed by some with the Middle Glacial. A list of these wells is given on pp. 22–29.

2. *Loam.*—This is sometimes a brown sandy clay, sometimes a stiff blue clay, both of them more or less laminated; but there seems no reason to make any difference in age between these two clays, either on account of their colour or because one is stiffer and less sandy than the other. The difference in colour is due very much to the amount of moisture in the clay, and the stiff blue

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* Mr. S. V. Wood, however, represented these divisions at Kenninghall (in his Section No. 11, in remarks in Explanation of Map, 1865).

† Horizontal Section, Sheet 127, of *Geological Survey*.

clays will be found to contain more water than the brown clays: weathering will also often cause the blue clay to become brown at the top. White bricks are made from the stiff blue clay and red bricks from the brown sandy clay.

The loam is best developed between Banham and Harling, where there is a conspicuous outcrop of it. Here, also, it rests more or less directly on the Chalk, with sometimes a bed of sand or gravel between. The stiff blue clay is absent from this area.

I have not heard of any fossils being found in the brickearth, beyond some pieces of wood at the Wretham kiln.

Merton.—Taking the western part of the area first, and beginning with the most northerly section, we have, three-quarters of a mile south of the church, a brickyard, showing 2 to 8 feet of brown and buff laminated brickearth, with sand interbedded in places. I was told that the brown earth made red bricks, and that the buff laminated earth made white bricks. I saw some very good specimens of window mouldings made from this buff brick earth.

Boulder Clay is dug close by, and appeared to overlie the brickearth.

Tottington.—Brickearth-outcrops for nearly one mile west of this place, where it used to be dug for brickmaking, but there are no good sections left now.

Wretham.—There is a good section half a mile north-east of the church, where there is a brickyard showing 8 to 10 feet of stiff, blue, laminated clay. I was told that bits of wood had been found in the clay. The exposure extends over a square mile.

Croxton Heath.—One mile and a half west of Roudham Station there is another patch of brickearth on low ground, surrounded by Boulder Clay, in which are some pits showing buff laminated loam.

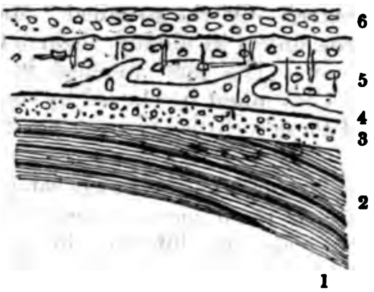
Hockham.—One mile east of the church is a section at an old brickyard showing 5 feet of buff loam.

Shropham.—About one-third of a mile south-east of the church another brickyard shows 5 feet of brown laminated loam. The upper part of the loam was rather chalky, which may be due to a capping of Boulder Clay; the loam also appears to rest on clay.

Attleborough.—One quarter of a mile south of the church the accompanying section was to be seen.

Fig. 1.

Section at Mr. Ketteringham's brickyard, south of Attleborough Church.



	Feet.
6. Very coarse gravel - - - - -	1½
5. Brown Boulder Clay - - - -	3 to 4
4. Blue Boulder Clay - - - - -	1 to 0
3. Coarse gravel and sand - - - -	1½
2. Blue laminated loam - - - -	3 to 7
1. Sand and water (not shown in the woodcut).	

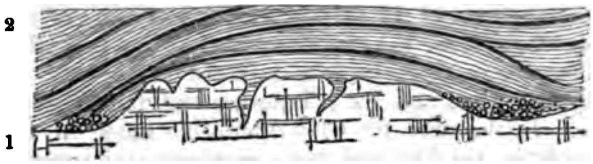
At Attleborough, opposite to the entrance to the Hall, is a now disused brickyard showing:—

Brown sandy loam, apparently passing into	8 feet.
Chalky Boulder Clay	3 ,,
Stiff, blue, laminated loam, not bottomed at	8 ,,

Banham.—Brickearth is largely worked here at the brickyard west of the church; sometimes the loam rests directly on the Chalk and sometimes on sand and gravel.

Fig. 2.

Section at the Banham brick-kiln.



2. Brown and grey clay, roughly stratified and resting in hollows in the Chalk, which are lined at the junction with thin brown clay, like the clay-with-flints. Pockets of fine, quartzose, pebbly gravel also occur here and there at the base of the clay; the gravel in places is highly ferruginous. The total thickness of these beds is about 15 feet.
1. Rubbly Chalk.

*Kenninghall.**—A brickyard, three-quarters of a mile north-east of the church, shows:—

Sandy red and grey mottled loam passing into stiff grey clay	15 feet.
Red and brown sand occurs irregularly in the clay.	

Two miles west of the church, and near the road, is a section at a brickyard showing the following section:—

3. White chalky Boulder Clay.	
2. Stiff, blue, Boulder Clay, resting irregularly on	2 to 6 feet.
1. Brown stony loam	7 ,,

A little further north, in the same brickyard, I was told that the loam had been worked to a depth of 33 feet.

Kimberly.—At the brickyard by the railway station the following section was to be seen:—

2. Brown and grey mottled stony clay	8 feet.
1. Chalky Boulder Clay.	

Wymondham.—Half a mile north-east of the church a section showed brown Boulder Clay resting on brown, sandy, laminated loam.

At Upper Downham there is a pit showing 7 feet of brown laminated loam, bluish at top. Another pit in the same field, a little to the south, showed 3 feet of brown laminated loam, resting on fine buff sand.

East-north-east of the church, and east of the high road to Norwich, the following beds were exposed:—

3. Brown Boulder Clay	1 to 2 feet.
2. Blue Boulder Clay, seeming to pass into	3 to 4 ,,
1. Clean, stiff, blue laminated clay	3 ,,

3. *Boulder Clay.*—The Boulder Clay on the west and south-west of this area differs so much from that on the east and north

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* *See* Mr. Wood's Section, No. 11, in his Remarks in Explanation of Map, 1865.

that we may say that we have here two Boulder Clays; but still it does not seem possible to separate them into an upper and lower Boulder Clay. There seems, however, to be fair evidence for concluding that these Clays are the results of two glaciations; the thin sandy Clay, with local detritus arising from a north-western glaciation, and the thick blue Boulder Clay, with erratic boulders, from a north-eastern glaciation. Nevertheless, they were formed contemporaneously; the two Clays being interbedded along the line, dividing the Clays. My colleague, Mr. A. Strahan, informed me that he had come to a similar conclusion from the study of the Lincolnshire Boulder Clays. Roughly speaking, a line drawn from the north-west corner of the map to within four miles of the south-east corner would show the areas occupied by the two Clays.*

The difference in character is maintained throughout the tract drained by the Thet and its tributaries, and the Wissey and its tributaries. In this area the Clay diminishes much in thickness, occurs mostly in patches, and has a maximum thickness of only 25 feet. It is a brown, sandy, and chalky Boulder Clay, and contains many unworn flints and boulders of local origin. Outside this area we have an almost unbroken sheet of the well known blue chalky Boulder Clay, with a maximum thickness of a hundred feet, and made up chiefly of chalk and flint in a clayey-matrix, with the usual assemblage of foreign boulders. The difference in lithological characters of the Clays in the two areas, coupled with the more foreign character of the detritus in the one clay than in the other, seem to prove that the difference is not so much due to denudation as to deposition. Some of the sections in the sandy Boulder Clay show signs of stratification, thin beds of chalky clay being interstratified with blue Boulder Clay. The area of the thin patchy, sandy, Boulder Clay is that of the heath tracts with their thin deposit of sand, covering alike both the Chalk and the Boulder Clay. Some of this sand, no doubt, results from the dissolution of the Boulder Clay through atmospheric causes, to which allusion will be made in another place; but the sand in the clay may, I think, have been derived from the Neocomian tract, as we find carstone in this clay, and also boulders of a sandstone which Mr. Whitaker tells me he regards as Neocomian also.†

It would hardly be of any use to mention particularly all the sections in the thick spread of Boulder Clay, as, although numerous, they do not differ materially.

Area drained by the Thet and Wissey.

Here, as has just been said, the Boulder Clay differs very much from that in the other part of the district, and here the sand covering prevails. The effect of this sand is to neutralise, in great measure, the fertile properties of the clay. To obviate this, pits used to be sunk into the clay in nearly every field, and the clay was then raised and the land dressed, with most beneficial and lasting results; but the high price of labour and the introduction of artificial manures have led to the complete abandonment of this method.

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* *See* papers by F. J. B., in Proc. Norwich Geol. Soc., vol. i., pp. 242, 252.

† For records of Drift fossils from Saham, Holm Hale, &c., *see* S. Woodward, Geology of Norfolk, pp. 36–42, and Pl. I; 1833

Hargham.—Two and three-quarter miles south-west of Attleborough, along the Thetford road, and at the corner of the road leading to Shropham, is a pit showing—

2. Coarse brown false-bedded sand - - -	3 to 5 feet.
1. Brown sandy clay, full of small chalk stones and some large little-worn flints; in the bottom of the pit was a boulder of grey (?Neocomian) sandstone with a glossy lustre when broken, containing small phosphatic nodules. At one part of the section the clay showed some signs of stratification, there being a layer of very chalky clay, then one of blue clay, then brown clay - - - -	10 to 12 ,,

One quarter of a mile further south-west along the turnpike road and to the north of it, near the four cross-roads, is a pit (marked on the map) showing—

2. Brown clay with patches of Boulder Clay in it, resting irregularly on - - - - -	4½ feet.
1. Very chalky grey Boulder Clay - - -	4½ ,,

Snetterton.—Half a mile south-east of the church the following section was to be seen:—

2. Red sandy soil with many flints, resting on the "piped" or weathered surface of
1. Very chalky Boulder Clay with little-worn flints; the clay is a brown sandy clay weathering white.

Eccles.—One mile west of Eccles Hall, and north-east of Overy Farm, is a pit which shows—

4. Dark blue Boulder Clay - - - -	1 foot.
3. Slate-coloured sand - - - - -	1 ,,
2. Whitey-brown sandy Boulder Clay - - -	3 to 6 feet.
1. Brown sandy Boulder Clay, with chalky seams -	7 to 12 ,,
Chalk shown at the bottom.	

Just north of Eccles Church is a large pit, much overgrown, showing—

3. Coarse red sand with traces of white and brown Boulder Clay - - - - - - - -	6 feet.
2. Very chalky Boulder Clay.	
1. Brown stony clay with few chalk stones.	
Chalk touched at bottom.	

Quiddenham.—A pit on the side of the road from Quiddenham to Harling, and just south of the parsonage, shows—

2. Coarse gravel and sand resting irregularly on
1. Brown chalky Boulder Clay, stratified at its base with blue Boulder Clay and also with loam and quartzose gravel; the Boulder Clays contain Lias boulders, and also some of grey (? Neocomian) sandstone with phosphatic nodules.

West Mere Hall.—Three miles west of Thompson in the north-western part of the area is a pit, one-quarter of a mile north of the "*M*" in the word "*Mere*" (on the map), showing 15 feet of chalky Boulder Clay with many large blocks of carstone; the floor of the pit, too, is strewn with carstone boulders.

Stow Bedon.—Half a mile due east of the church is a pit showing—

2. Brown Boulder Clay interstratified in one part with layers of blue Boulder Clay - - -	20 feet.
1. Rubbly Chalk.	

As before mentioned, the whole area of the thin sandy Boulder Clay abounds in pits, and to enumerate them all would hardly serve any useful purpose. Most of the instructive pits have been noted, and the positions of many of the others are engraved on the map, so that they can be visited by any one interested in the matter.

There are a few sections showing masses of marl, sometimes capped by brown Boulder Clay, sometimes marl from top to bottom. Two or three examples will be given of these.

Thompson.—Three-quarters of a mile south-west of the church, and north of the "*s*" in "*Thompson's Hall Cottages*" (on the map), a pit shows—

Brown Boulder Clay - - - - -	4 feet.
Marl - - - - - -	12 ,,

Nearly one mile south of the church is a marl pit. Another pit, one mile and a quarter south of the church, is also in marl, and is 12 feet deep. Indeed, on the west the Boulder Clay is so very chalky that it is sometimes difficult to draw the line between the Chalk and Boulder Clay.

Boulders.—In the western part of this area some large boulders are to be seen; they mostly seem to be sandstones of Neocomian age, and are formed of a compact grey stone, which, when broken, has a lustrous appearance. They contain dark nodules of a phosphatic nature; fragments of *Inoceramus* (?) were seen in one boulder. The Merton boulder, which is the largest in the area, and is of considerable repute, is, in Mr. Whitaker's opinion, a boulder of Neocomian sandstone.

Threxton.—Just outside the public-house at Threxton, by the four cross roads, there was a large boulder, also another outside the farmhouse, half a mile south of Claremont Lodge. Half a mile east of Threxton House, and 1½ miles N.W. of Merton Church, by a hedge, and lying partly in a pond, is the "Merton Boulder;" it measured 12 × 5 feet, and being partly under water, the thickness could not be ascertained. Three-quarters of a mile S.E. of Threxton House, and one mile west of Merton Church, was a boulder 3½ feet long by 2 × 2, with many fossils, mostly *Ammonites.*

Bunwell.—At the brickyard by Bunhill Wood, where Boulder Clay is dug and washed for brick-earth, I saw a large boulder of very coarse grey grit (Millstone Grit ?), made up almost entirely of quartz.

4. *Coarse "Cannon-shot" Gravel and Sand.*—Resting on the Boulder Clay, and rarely occurring beneath it, we find in this area patches of coarse gravel and sand. In no case is there any wide spread of it, nor do the patches occur in any particular order; they are scattered about all over the area. It occurs sometimes on the slope of a valley, cropping out as a bed in the Boulder Clay; at other times it caps the high ground. There are only two cases in this area where I have seen Boulder Clay resting on gravel and sand, and then the gravel occurred as a boss, nearly rising through it (*see* p. 15 and fig 6). It is so intimately connected with the Boulder Clay that it must, I think, be regarded as a gravelly condition or equivalent of the clay, for sometimes the stones rest in a matrix of red clay. The gravel is a very coarse flint gravel, and the stones show every mark of extensive water-action, as they are much rounded and battered. In some instances the spaces between the large stones are filled up with sharp angular or broken and sub-angular flints. It is very rare indeed to find any other stone than flint, with the exception of pebbles of quartz and

quartzite; only now and then is a boulder of igneous rock met with.

It is impossible to separate the sand in this area from the coarse gravel; both rest on Boulder Clay, so that we may consider the sand as of the same age as the gravel. The sand is almost confined to a small area south of Attleborough.

Commencing with the western edge of the Map, and proceeding eastwards, we have first, west of Watton, the following sections:—

Threxton.—One-quarter of a mile south-west of the church and north of the road, a pit shows 10 feet of coarse sub-angular gravel, red at top but chalky at the bottom, roughly stratified in places with coarse sand. The stones mostly stand with their longer axes vertical. The section is on the side of a valley. Boulder Clay touches it, and as water is seen in the bottom of the pit, the floor may be on Boulder Clay.

Half a mile south of the church is another pit showing 12 feet of angular gravel, chalky in places, with large and much-worn flints, showing stratification.

One-quarter of a mile north-east of the church is a large pit showing—

4. Very coarse angular gravel in sandy matrix	7 feet.
3. Chalky pebbly gravel - - - -	2 ,,
2. Fine buff sand, not bottomed at - - - -	2½ ,,

The floor of the pit holds water and seems to be made of buff loam.

Thompson.—One third of a mile south of the church a pit shows—

Very coarse much-rolled flint gravel in red clayey matrix, with pockets of angular and unworn flints -	7 feet.

There is an old disused gravel pit to the north of this 15 feet deep.

Sturston Warren.—Gravel and sand of greater or less thickness have been mapped over the high plateau of Sturston Warren, and there is a deep pit in the coarse gravel close to the high road and just south of the "*n*" in "*Warren*" (on the map). This is seen to rest on Boulder Clay in places.

Wretham.—At the south end of the cutting north of the Wretham Railway Station, 10 feet of coarse brown sand with pockets of much-worn flint gravel were seen. At the south end of the cutting the sand is finer, and has a thin band of loam in it; it also seems to rest on brickearth. A pit east of the north end of the cutting showed 12 feet of fine yellowish sand with a lenticular patch of laminated loam.

Hockham.—Three-quarters of a mile north of the church is a large gravel pit, which shows an irregular bed of sand resting on coarse flint gravel, much worn, in red clayey matrix, with pockets of sharp angular gravel, mostly near the top; together 10 feet in thickness.

Carbrooke.—One mile south of the church, by the four crossways, is a very large pit showing 20 feet of very coarse much-worn gravel. Boulder Clay surrounds the pit on all sides.

Woodrising.—One-quarter of a mile north-east of the church is a very large pit in the coarse gravel, showing a thickness of 15 feet; the gravel is on the high ground, but comes down into the valley, though it does not cross it.

Rockland.—Coarse gravel caps the high ground south of the churches of Rockland All Saints and St. Andrew, and is worked in a pit half a mile south of these churches. It descends the valley on the west but does not cross it. The pit shows 18 feet of coarse gravel. South of this, two other patches of gravel have been mapped.

Snetterton.—One mile south-east of the church is a pit showing coarse flint gravel, passing under Boulder Clay at a sharp angle. One mile north-east of the last pit, and close by the high road, is a pit in 10 feet of coarse gravel and sand.

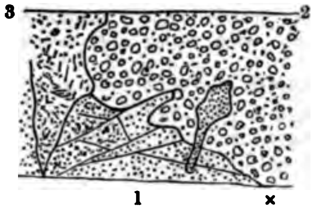
Eccles.—One mile south-west of the railway station, and west of the line a cutting has been made for ballast, and showed 10 feet of brown sand and very sandy loam. They seem to rest on Boulder Clay, though the junction is not seen. Eccles Station likewise is on sand underlaid by Boulder Clay.

A gravel pit on the heath, one-quarter of a mile west of Eccles Hall, shows an irregular thickness of gravel and sand, 15 feet in places. The gravel is made up of stones in all stages of wear,—angular, sub-angular, and pebbles,—and of all sizes, with some very large flints. In the upper part the beds are unstratified, but in the bottom part they are roughly stratified. Flint preponderates, next come chalk pebbles, then fragments of (? Neocomian) ironstone, quartz, and, lastly, quartzite. Chalky sand is seen at the bottom of the pit. The stones at the top lie at all angles.

Quiddenham.—One-quarter of a mile west of Quiddenham is a pit showing the following section:—

FIG. 3.

Section west of Quiddenham Church.



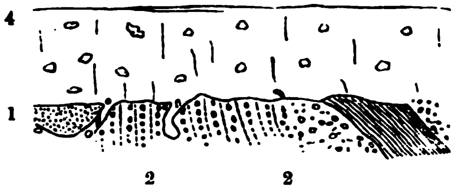
3. Sand-pipe passing through the gravel and sand.
2. Coarse flint boulder gravel with occasional chalk pebbles. The upper part is in a clayey matrix, and resembles very stony Boulder Clay; it is much less clayey lower down - - - 3 to 7 feet.
1. Rather coarse false-bedded chalky sand; along the line marked × there is a band of chalky sand, rather clayey, as fine as flour - - 3 to 0 ,,

Harling.—At the bottom of a lane, a little east of the church, is a pit showing 7 feet of fine, buff, mealy sand, with a little fine gravel at the top.

Bridgeham.—Half a mile due west of the church is this section:—

FIG. 4.

Section half a mile west of Bridgeham Church.



4. Brown and blue Boulder Clay passing under the sand and into the gravel, chalky in places, and seeming to merge into the chalky gravel.
3. Buff sandy loam.
2. Chalky gravel and sand.
1. Fine buff sand.

One mile north-east of the church and just west of the "*S*" in "*Sand-pit Hill*" (on the map), is a pit showing vertical junctions of sand and Boulder Clay.

Banham.—At the lime-kiln the chalk is capped by a considerable thickness of false-bedded ferruginous sand, with a little gravel and loam, much resembling Crag; the sand is very irregular and occurs in pipes in the chalk.

Half a mile north-west of the church the following section was to be seen :—

2. White Boulder Clay - - - -	3 to 10 feet.
1. Very coarse gravel with large flints, some of them very little worn, rising nearly through the Boulder Clay.	

Three-quarters of a mile north of the church is a large pit showing 12 feet of coarse gravel and sand; the gravel occurs very irregularly in the sand, and I was told that it rested on clay. One third of a mile west of the last pit, is a pit showing 7 feet of angular and sub-angular gravel.

Old Buckenham.—Three-quarters of a mile south-south-west of the church, and one mile and a half north of Banham Church, are three gravel pits. The first on the west shows 8 feet of coarse gravel resting on Boulder Clay. The most easterly pit shows more signs of bedding than the other, and is 12 feet deep.

The gravel here caps the high ground and makes a feature. It is more worn than most of the coarse gravel, and occurs roughly interbedded with and also in pockets in coarse brown ferruginous sand. The gravel is composed mostly of flint with some boulders of Lias and sandstone. Many of the small pebbles are of quartz.

Two patches of sand have been mapped about two miles west of the church, by Leys Plantation and Hargham Common. The sand is a coarse brown sand, ferruginous in places; it is of no great thickness and rests on Boulder Clay.

Hargham.—A pit by the corner of the road to Shropham, showed from 3 to 5 feet of coarse false-bedded brown sand, with a little gravel in places, resting on Boulder Clay.

Attleborough.—The town stands on a slight rise, formed by a thin and variable deposit of coarse gravel resting on Boulder Clay. No pits in this can now be seen, although at one time gravel used to be worked in a field at the back of the Bear Inn, a little north of the church. About half a mile south-west of the church, and west of the high road, is a gravel pit which showed 20 feet of coarse gravel, but it is filled up again now.

One mile south of the church a pit showed 3 feet of ferruginous, coarse, and false-bedded brown and red sand, much resembling Crag sand.

One mile north-west of the church, and just north of Cakes Hill, is a large pit. "Here a small hole dug in the grown-over bottom of the old part of the pit, for water, touches Boulder Clay. The gravel is coarse, rather like the cannon-shot gravel of Norwich. At the north there are traces of clayey earth at top (? Boulder Clay or the wash thereof from higher ground near by)."* This pit shows 25 feet of gravel, and has been worked to a depth of 30 feet. There seems little doubt that the "clayey earth" mentioned by Mr. Whitaker is Boulder Clay, as I saw traces of chalk in it.

One quarter of a mile west of Attleborough Hall a pit has been opened in the coarse gravel, showing a thickness of 10 feet.

Besthorpe.—Mr. Pooley, a well-sinker, told me that on the Decoy Common a variable thickness of gravel and sand filled up hollows in the Boulder Clay, the greatest thickness being 60 feet.

Morley St. Botolph.—At the windmill north-west of the church is a pit in gravel of very irregular thickness, made up of coarse angular and sub-angular stones in a clayey matrix.

Deopham.—A little south of the church a pit shows 8 feet of coarse flint gravel interbedded with coarse red sand; the large flints are much rolled, but the finer gravel is angular and sub-angular, in a red clayey matrix. One mile west of the church is a pit in 10 feet of coarse gravel.

Hackford.—Three-quarters of a mile north of the church a pit, 20 feet deep, showed coarse flint boulder gravel, in a matrix of finer sub-angular gravel, with small chalk pebbles. A mass of Boulder Clay was seen in the gravel in one place; this gravel rested on Boulder Clay.

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* From Mr. Whitaker's notes.

Kimberly.—Three-quarters of a mile south-east of the church is a large pit showing the following beds:—

Coarse gravel in a matrix of angular gravel -	7 feet.
Finer gravel and brown sand -	2 ,,
Buff and white chalky sand -	5 ,,

Wymondham.—Half a mile west of the church, and at the back of Cakewick House, is a large overgrown gravel pit, 20 feet deep, showing boulder gravel over sand. Half a mile south of the church and west of the high road is a large pit showing 8 feet of coarse gravel in red matrix, much rolled, but with pockets of angular and unworn flints, with a little sand in one place. The stones stand in all positions, and the arrangement is tumultuous.

One mile north of Wymondham Church the following section was exposed:—

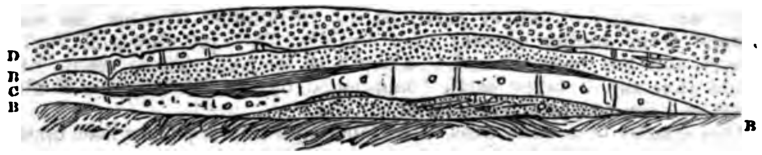
4. Clayey soil.	
3. Coarse flint gravel -	8 feet.
2. Brown false-bedded sand -	10 ,,
1. Fine, white, false-bedded sand, like meal -	

The sand, no doubt, was once all white, the brown colour being due to infiltration of oxide of iron from the gravel over it.

"Near the railway station, at the new road-cutting, the accompanying section was exposed in 1876. It proved the very irregular nature of the chalky Boulder Clay and associated sands. The total thickness of the beds exposed was about 30 feet. The uppermost bed was a coarse boulder gravel—the 'Cannon-shot' gravel of Messrs. Wood and Harmer. The underlying beds include representatives of the chalky Boulder Clay (Upper Glacial), and of sands that appear identical in character with the 'Middle Glacial.' At the same time, the irregular position of the beds forbids any attempt at this classification."*

Fig. 5.

Section at Wymondham Railway Station.
By H. B. Woodward.



D. Boulder gravel, 6 to 10 feet.
C. Stiff brown and purple clay.
B. Boulder clay, about 8 feet in places.
A. Sand, 4 to 10 feet in places.

West of the railway station the best section of the coarse gravel is seen, where the cutting shows about 12 feet of the coarse gravel resting on false-bedded buff sand; Boulder Clay is seen to underlie the sand in places.

The first cutting, east of Wymondham towards Forncett, is all in gravel. At Stanfield Green, Boulder Clay is seen on the gravel, but only as a patch of small extent. The main mass of gravel and sand rests on Boulder Clay. The following section is an attempt to show the relation between the gravel and sand and Boulder Clay, the broken line being an inferential one :—

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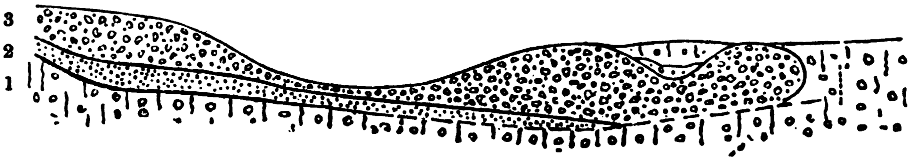
* From Mr. H. B. Woodward's notes.

Fig. 6.

Section on the Wymondham and Forncett Railway.



3. Coarse gravel.
2. Fine buff sand.
1. BoulderClay, chalky at bottom, brown and mottled at top.

The Heath Tract.

The greater portion of the south-western corner of the area is occupied by heaths, for the most part uncultivated. They are, Illington Heath, Larling Heath, Harling Heath, Bridgeham Heath, Croxton Heath, Tottington Heath, and Sturston Warren. This tract supports little else than sheep and rabbits, though portions are now and then broken up and sown with rye, and occasionally with turnips.

The uncultivated parts are covered with the usual vegetation of heather and brake fern.

Mr. H. Stevenson, in his "Birds of Norfolk," speaks of this as the "Breck district." He says :—

"The greater part of this district consists of what are locally called 'brecks,'—that is, ground which at some time or other has been 'broken up' by the plough, and hence the name here assigned to it. Many of these 'brecks,' never very fertile to begin with, through bad farming and consequent exhaustion of the soil, have been long abandoned as arable land, and are now used as sheep-walk; but others form, in many cases, commons or heaths, on which the hasty observer would never recognize the trace of a plough. Not that there are not, however, some extensive tracts, which have, probably, never been under cultivation." (*See* p. 8.)

Chalk comes to the surface over the greater part of this area, or is covered only by a thin deposit of Boulder Clay, very different from that clay on the east, being much more sandy. But the geology is much obscured by a mantle of sand spread over Boulder Clay and Chalk alike. To account satisfactorily for this uniform covering of sand is very difficult, but the following explanation is offered as a likely one.

We first have to find whence this sand came, and then how it was distributed, but though the past tense is here used, we have also to deal with the present, for the formation and distribution of the sand is still going on.

One source was and is, no doubt, the sand and gravel found in patches here and there on the Chalk, and on the Boulder Clay, which, like the Chalk, contains pipes of sand or sand "golts." Decomposition of the sandy Boulder Clay from atmospheric causes would also yield a supply of sand.

The heath tract forms a plain of moderate elevation, though comprising some of the highest ground in the area; it has few trees, and formerly had fewer, all the fir plantations, or "belts," as they are termed, being of recent introduction. It occupies a part of England, too, where the rainfall is small, and lies within 30 or 40 miles of the coast. The soil is light and dry, and is freely exposed to the influence of sun and wind, which would operate powerfully in reducing it to a sandy condition, so that when the strong winds prevail sand storms would ensue, and great tracts of country would be covered by the sand thus distributed.* Now these sand storms are of no infrequent occurrence. In 1668 a most remarkable one happened at Downham, an account of which appears in the Philosophical Transactions of that year, entitled "A curious and exact Relation of a Sand-floud, which hath lately overwhelmed a great tract of Land in the County of Suffolk."†

Some remarks made by Mr. Stevenson on the extermination of the Bustard (*Otis tarda*) from this district are of sufficient interest to be quoted here. He says:—

"Its chief destroyer was most assuredly the agriculturist. He found his crops wanted shelter, and planted long belts of trees to keep the wind from carrying his soil to the next parish, and removing his own or his neighbour's landmark.

"The effect of high winds after dry weather in this district is not easily described. The whole air is filled with sand till it resembles a London fog. Nearly every particle of fertilising matter is blown away from the land, as is shown for years afterwards by its barrenness."‡

ALLUVIAL DEPOSITS.

There are no wide valleys in this area, and no great volume of water, so that the alluvial deposits are of very small extent. The widest spread of Alluvium is south of Harling Road Station. Next to this is a tract of sandy and gravelly Alluvium west of Snetterton; then we have Swangey, Banham, and Old Buckenham Fens, of small extent and much reduced by modern draining operations. At the latter fen Mr. T. Southwell states§ that bones of Roebuck (*Cervus capreolus*) have been dug up by turf-cutters. The Red Deer (*C. elaphus*) has been dug up from Saham Mere.‖

On Decoy Common, or Besthorpe Fen as it is called, there is a small extent of Alluvium; there used to be a decoy there. I was also told that at a depth of 6 feet, oak trees were found resting on Boulder Clay with evidences of having been felled.

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* For further discussion on this question, *see* The Geology of the Neighbourhood of Diss, &c. (Mem. Geol. Survey).

† Vol. iii., No. 37, p. 722 (Abridgment by Lowthorpe, vol. ii., p. 265.). See also S. B. J. Skertchly, Geology of the Fenland, p. 194 (Memoirs Geological Survey); and F. J. B., Geology of Diss (Mem. Geol. Survey).

‡ Birds of Norfolk, vol. i., p. li. The Bustard was exterminated about 1838.

§ Lubbock's Fauna of Norfolk (new edition, by T. Southwell).

‖ S. Woodward, Geol. Norfolk, p. 36.

Valley gravel has been mapped in places, but it is of no great thickness, and there are no sections in it; it is mostly a coarse sub-angular gravel with iron pan in places.

The Meres.—The meres, or "pits" as they are locally termed, form the most interesting and picturesque feature of this area. Most of them are situated in the south-western part, in the centre of the wild heathy tract called Croxton Heath. They generally consist of small circular pools of water occupying crater-shaped hollows, with neither outlet nor inlet, and they are confined to that portion of the district where the Chalk comes to the surface, or where it is only very thinly covered by sandy drift.

An examination of this heathy tract shows that the ground is pitted with a great number of these hollows, nearly all of which are dry at the bottom, though some of them contain water after much wet weather. At one time, no doubt, all these holes had water in them; but as the country around was from time to time brought into cultivation and the land drained, the water-level in the Chalk, whence these meres derive their supply, was lowered, and so most of them became dry.

How are we to account for these hollows, and to what are they due? It is well known that the surface of the Chalk is much "piped," and that some of the pipes extend to a great depth and are filled with gravel, sand, or clay. In this area they are filled with sand, this being the locally prevailing drift over the Chalk. After a heavy rainfall the water would fill these pipes, passing down into the water-level of the Chalk where they penetrated deeply enough, and enlarging the hole to that level by the dissolution of the Chalk where previously there was no connexion. Again, as the water-level in the Chalk rose, so would the water ascend, rising through these pipes by preference, and falling, of course, as the level fell; this rise and fall of the water through these pipes, acting chemically and mechanically, would enlarge them till the basins were formed.

That these meres are all fed from springs from the Chalk at the same water-level is probable from the fact that they are all at nearly the same height above the sea; and, moreover, that a line drawn south from Saham Mere, near Watton, to Ringmere, would touch nearly all of them, those outside it being only a little either to the east or west of it. Tradition says that Fowlmere was once sown with oats and the crop lost by the *sudden influx* of the waters, which again points to their connexion with underground springs.

Ever since Mickle Mere (which seems to stand rather lower than the rest) was pumped dry by steam power and deepened by Mr. Birch in 1856, the water has stood higher in them all, and none of them have since then been dry, though such a thing had been known to occur in former years.

The beauty of these meres is much enhanced from their being the resort of numerous flocks of wild fowl. Mickle Mere has been a decoy for a number of years.

The meres in the Chalk area are:—Saham Mere on the north, near Watton, and Mickle Mere, six miles south of it. This last, with Hillmere and Scot Mere, are in Wretham Park; then Home Mere with Fowlmere and Punch Bowl Mere lie to the west; Longmere and Ringmere occur two miles south of Mickle Mere; and eight miles to the east of Ringmere is Quiddenham Mere.

These meres situated in the Chalk area may be called meres of the first class.

Besides these meres in the Chalk area, there are four others in a Boulder Clay area, which may be called meres of the second class. They are situated in the course of streams, are very shallow, and arise from the partial damming up of the streams. They are:—Stow Bedon Mere, Scoulton Mere, Wicklewood Mere, and Sea Mere, near Hingham, this last has partly the look of a mere of the first class, its north bank being very steep.

Taking these meres in detail we have, first, on the north Saham Mere at Saham Tony, about one mile north-west of Watton; it is 13 acres in extent. Boulder Clay touches it on the east and south; on the west there is an inlier of Chalk. This mere has an outlet, which, however, seems to be an artificial one, and to be for the purpose of taking the overflow water.

Mickle Mere, six miles due south of Saham Mere, is by far the largest one, and contains 48 acres of water. Boulder Clay touches it on the north, and loam on the south, but Chalk is seen here and there around it, and it lies in a Chalk area.

Mickle Mere is of much interest, owing to the evidence of pile or lake dwellings found in it when drained and deepened by Mr. Birch in 1856.

References to Mickle Mere are made by Sir Charles Bunbury in a paper written in 1856, entitled "Notice of some appearances observed on draining a Mere near Wretham Hall, Norfolk;"* and also by Professor A. Newton in a paper read before the Cambridge Philosophical Society in 1862 (but separately printed) "On the Zoology of ancient Europe." Professor Newton also records the discovery of the fresh-water tortoise near Wretham, in a paper entitled "On the discovery of ancient remains of *Emys lutaria* in Norfolk."†

Sir Charles Bunbury states in his paper that when Mickle Mere was drained by Mr. Birch, 20 feet of black peaty mud formed the bottom, consisting of soft, rotten, unconsolidated peat; at about 15 feet in this peat was found a distinct horizontal layer, 2 to 6 inches thick in various parts, of compressed but undecayed moss of the species *Hypnum fluitans.* This moss was absent from some parts of the mud. Horns of Red Deer were also found in the peaty mud at 5 to 6 feet below the surface; some horns were attached to the skull, and some seem to have been sawn off "by human agency." The peaty mud rested on a bed of light grey sandy marl "effervescing with acids." No traces of shells were seen, but pieces of birch and the trunk of an oak of considerable size were found. Impersistent layers of white sand were found in the mud, and a few flints and quartz pebbles.

Numerous posts of oak wood, shaped and pointed by human art, were found standing erect, entirely buried in the peat; and thus a great part of the mud overlying the moss must have been accumulated *before* the Red Deer became extinct.

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* Quart. Journ. Geol. Soc., vol xii., pp. 355, 356, 1856.

† Ann. and Mag. Nat. Hist., Ser. 3, vol. x., pp. 224-228, 1862.

M. Troyon* takes the evidence of the pointed oak posts found standing erect as proving the existence of pile buildings in Mickle Mere.

Mr. H. Stevenson† states that besides the bones of the Red Deer found at Mickle Mere there were those of the *Bos longifrons*, goat, and pig.

Hill Mere, which seems to be the same as the *West Mere* mentioned in Professor Newton's paper, is a little west of Mickle Mere; it is from 5 to 6 acres in extent. In 1851 Mr. Birch drained West Mere, and an account of a lake or pile-dwelling, and of the bones also found, is given by Professor Newton, who says ‡—"In this mere there was ordinarily about 4 feet of water, and beneath it about 8 feet of soft black mud, partly held in suspension and requiring to be removed in scoops. When the mud was being cleared out a great number of bones were discovered, chiefly deposited, as from its semi-liquid nature might have been expected, at the bottom. They were nearly all those of the Red Deer (*Cervus elaphus*) and the now extinct *Bos longifrons;* but among them also was a goat's skull with the horn cores, and the skull of a boar or pig of some sort. Near the centre of the mere, lying below the black mud, was found a ring or circular bank of fine white earth. . . . . The ring or bank was some 20 or 30 feet across, a foot wide, and about 4 feet in height. Not far from its inner circumference was a circular hole about 4½ feet in diameter, some 6 feet deeper than the bottom of the mere, and, as my informant states, almost like a well to look at; the mud it contained was even softer than that elsewhere, this was marked out by a circle of stout stakes or small piles apparently of alder (*Alnus glutinosa*), and it bore traces of having been wattled. It was not the centre of the ring, and between the two circles were the remains of a wall composed of flints packed together with marl or soft chalk. In the same place was some earth of a bright blue colour, which, when dried, crumbled to powder, and was not preserved. . . . . . In this interspace a still greater number of bones were found, and also the remains of a rude ladder, but in such a state of decay it could only be pulled out piecemeal. Still, enough of it was seen by Mr. Birch *in situ* for him to have no doubt as to its original form. . . In and around this ring there lay a vast number of bones, of which no small portion were the upper parts of the skull of *Bos longifrons*, with the horn cores attached, and many antlers of the Red Deer either entire or in fragments. All the former, excepting one unusually large example, had a fracture in the forehead." Professor Newton states that "of the deer's antlers some had been naturally shed, and some had been separated from the skull by sawing, and that most of the larger bones found had been opened to obtain the marrow, and that one bone of the Long-fronted ox had been polished on one side. No weapons or implements of metal were found, only some flint discs, which from the description I have received (for, unfortunately, none of them seem to have been preserved) must have closely resembled those known to the Danish antiquaries as 'sling-stones,' from the probable use made of them."

Professor Newton then quotes the evidence of the oak posts found in the Great Mere, and says:—

"Yet, on the strength of Sir Charles Bunbury's concluding statement, M. Troyon (Hab. Lacustr., p. 91) does not fail to recognise the similarity between the Norfolk antiquities and the Pile-dwellings of his own country, much more, therefore, would he certainly be inclined to declare the facts I have just stated to be indications of true lacutrine habitations in England.

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* Habitations Lacustres des Temps anciens et modernes, p. 91, 1860.

† Trans. Norf. and Nor. Nat. Soc., Vol. i.

‡ On the Zoology of Ancient Europe, 8vo, Lond. 1862.

"Some weeks since, when examining the large collection of ancient remains in Mr. Birch's possession, all of which were, I believe, found on his estate in Norfolk, I found, to my surprise, some specimens far more interesting than any I had expected to meet with. . . They consist of some limb-bones and a considerable portion of the dorsal and sternal shields of two individuals of the European freshwater tortoise (*Emys lutaria*)—a species the existence of which at any time in the British islands has never before been suspected. These were found, as a label upon them in Mr. Birch's handwriting testifies, so long ago as June 1836, in a peat bog, by the side of a spring-pit, at East Wretham, about 7 feet below the surface and beneath some 1,500 laminations of a species of Hypnum, specimens of which were, I understand, submitted by Mr. Birch to Sir William Hooker, who declared the species to be Hypnum filicinum. I immediately communicated these facts to Professor Owen and Professor Bell. . . ., and subsequently sent the remains to the first-named gentleman, who kindly determined the species for me, thereby confirming the view I had taken of them, but adding that they were somewhat larger than modern examples from Germany now in the British Museum."

Fowlmere.—This is next in size to Mickle Mere, and is about two and a half miles to the south-west of it; it is of an irregular outline. Boulder Clay seems to touch it on the western side, while on the east, where the bank is fairly steep, Chalk is seen.

Mr. Stevenson* states that in 1859 it consisted of only a small pond at the further end of the basin, and that the rest was cropped with wheat, oats, and vetches; that tradition speaks of it having once been quite dry, and that the crop of oats sown there was lost by the sudden influx of the waters. I was told that since Mickle Mere was deepened Fowlmere has occupied a much larger area than before. In January of 1884 it covered a considerable space, and had two little meres on the eastern side of it.

Punch-bowl Mere.—This is immediately south of Fowlmere, and is the best example of the crater-shaped form, the sides being very steep; the water varies very much in depth.

Home Mere, with another one, are three-quarters of a mile to the west of Fowlmere; these are also good examples of the crater-shaped basins, though on a much smaller scale than Punch-bowl Mere.

Longmere Pit, two miles south of Mickle Mere, is most picturesque. It is of a long oval form, nearly half a mile in length, has an island in the centre planted with fir trees and covered with gorse.

It is very shallow, and Mr. Stevenson* states that in the summer of 1859 it was entirely dry, but that since then it has always been full.

Ringmere Pit, half a mile to the south of Longmere, is a small circular piece of water, and was also dry in 1859. In some wet seasons it overflows for three miles, to the houses of Roudham.*

Quiddenham Mere, in Quiddenham Park, is eight miles east of Ringmere, and is a small oval piece of water.

We now come to the meres of the second class:—

Tottington.—Along the course of the stream between Tottington and Thompson are two or three small pieces of water: Thompson "Watering" is the largest.

Stow Bedon Mere may be due to Chalk springs, but it has a distinct outlet, and seems to be gradually growing up, and when visited in 1882 little water could be seen.

Scoulton Mere, five miles east of Watton, is very shallow, and has an island in the middle, which takes up most of the space. It takes its rise at the head of a small stream flowing west to Watton; the damming of this stream seems to have formed the mere. It is well known as the home of the Scoulton gull, which breeds in great numbers on the island; it is two miles in circumference, and is surrounded by a belt of trees, and lies wholly in the Boulder Clay.

Rockland Mere, one mile north of Rockland St. Peter's church, no longer exists, having been drained quite dry.

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* H. Stevenson, Trans. Norf. and Nor. Nat. Soc. 1869-70, p. 36.

Seamere, one mile south-east of Hingham church, is drained into by two small streams, and has an outlet by the stream flowing to Hackford. Its north bank is very steep, giving it the look of one of the meres of the first class, but it is surrounded by a thick spread of Boulder Clay. I was told it was 25 feet deep.

Wicklewood Mere is two miles north-east of Seamere, and along the course of the same stream. It is very small, and is almost filled up with sediment and vegetation.

SURFACE PHENOMENA.

Subsidence.—A remarkable subsidence, though on a small scale, occurred in August 1879 in the parish of Rockland, on a farm in the possession of the Rev. D'Arcy Preston of Attleborough, to whom I am indebted for the following particulars. He states that the summer had been a wet one, and that, suddenly, with a noise as of thunder, the ground gave way, causing a deep shaft, up which water rushed, stopping 10 feet from top. He measured the hole and found it 30 feet deep; it gradually closed up to within 10 feet of the top, when it was filled up. The spot where the subsidence took place was on fairly high ground, occupied by Boulder Clay containing patches of coarse gravel and sand. Just below the subsidence there may have been a nest of gravel or sand thinly covered by Boulder Clay; the water that filled the hole may have risen up this pipe and have washed out the sand and gravel, and the support being removed may have caused the roof of the hole to fall in. When I saw it some time after the occurrence the hole was perfectly cylindrical and some 10 feet deep and 6 feet across, but there was no water in it.

WELL SECTIONS.

These are entirely in the Drift deposits; the underlying Chalk being nowhere reached.

1. Attleborough.—At Mr. Ketteringham's brickyard.*

	Feet.
Loam	10
Sand	7
Boulder Clay	50
Black Clay.	
	67

2. Attleborough.—Opposite Corn Hall.*

Gravel	5
Red sand	14
Water unfit to drink.	
	19

3. Attleborough.—One mile south of the Church.†

(Boulder Clay)	44
Good supply of water.	

4. Attleborough.—Near the Baptist Chapel.

Gravel	5
Sand	4
(Boulder Clay)	10
	19

5. Attleborough.—North end of Station Road, first house.†

Gravel	10
Loam	3
Gravel and water.	
	13

6. Attleborough.—Second house from north end of Station Road.†

(Boulder Clay)	18
Gravel and water.	

7. Attleborough.—Sixth house from north end of Station Road.†

(Boulder Clay)	44
Water rose to the surface.	

8. Attleborough.—At the Royal Hotel.†

Gravel	9

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* Sunk and communicated by Mr. Pooley, of Besthorpe.

† „ „ Mr. Lincoln, of Attleborough.

9. Attleborough.—At the Royal Hotel, another well.*

		Feet.
Glacial Drift	Gravel	5
	(Boulder Clay)	7
		12

10. Attleborough.—At the Point House.

Gravel	12

11. Attleborough.—At Mr. Long's, south of Station.†

(Boulder Clay)	20
To sand and water.	

12. Attleborough.—At cottages south of Station.†

Sand and gravel	12

13. Attleborough.—At Kent House, London Road.†

Gravel	6
(Boulder Clay)	2
To sand.	
	8

14. Attleborough.—Another one further south.†

Gravel	4
(Boulder Clay)	35
	39

15. Attleborough.—At the King's Head Inn.†

(Boulder Clay)	60

16. Attleborough.—Connaught Road.†

Glacial Drift	Brick-earth	15
	To gravel.	

17. Attleborough.—Connaught Road, another well.†

Gravel	11

18. Besthorpe.—At Prince of Wales' Inn.*

Loam	2
(Boulder Clay)	6
	8

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* Sunk and communicated by Mr. Pooley, of Besthorpe.
† ,, ,, Mr. Lincoln, of Attleborough.

19. **Besthorpe.**—Another well close by.*

	Feet.
Gravel	4
Red sand	6
White sand.	
	10

20. **Besthorpe.**—At Fox and Hounds Inn.*

Loam	3
Black Clay	7
Gravel	4
	14

21. **Besthorpe.**—On Norwich Road by 13th milestone.

Gravel	12
Water rose to surface.	

Besthorpe.—Another well a little north of last.*

(Boulder Clay)	60
Not sunk through.	

23. **Besthorpe.**—Corner of Sluts Lane.*

(Boulder Clay)	10
White sand	7
Water rose to surface.	
	17

24. **Besthorpe.**—One mile east of Besthorpe Church.*

(Boulder Clay)	18

25. **Besthorpe.**—At Heron's Farm.*

(Boulder Clay)	87
Small supply of bad water.	

26. Near **Burfield Hall** by Wymondham.*

(Boulder) Clay	56
To sand and water.	

27. **Bunwell Street.**—By the Chapel.*

(Boulder) Clay	23

28. **Bunwell Street.**—Another well close by last.*

(Boulder) Clay	60
To sand and water.	

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* Sunk and communicated by Mr. Pooley, of Besthorpe.

† " " Mr. Lincoln, of Attleborough.

29. Bunwell.—In Bunwell Wood.*

	Feet.
(Boulder) Clay	25

30. Bunwell.—In Brick-kiln Lane.*

(Boulder) Clay	20
To sand and water.	

31. Carlton Rode.—Mr. Austin's cottages by turnpike road.*

Sunk 40 feet, bored 20 feet.

(Boulder) Clay	50
To sand, water rose 20 feet.	

32. Carlton Rode.—At Mr. Bett's, by side of turnpike road.*

Sunk 40 feet, bored 20 feet.

(Boulder) Clay	60
To sand, water rose 30 feet.	

33. Carlton Rode.—In Hargate, three-quarters of a mile south-east of the Church.*

(Boulder) Clay	30
Moory bottom.	

N.B.—Mr. Banham sunk 20 more wells in Carlton Rode from 20 to 30 feet in (Boulder) Clay; water supply from "land springs."

34. Deopham.—One mile south of the Church.†

(Boulder) Clay	90
To Chalk.	

35. Deopham.—At Low Common.†

Black sand	8
Water rose to surface.	

36. Deopham.—Near the Church.†

Glacial Drift	Gravel	4
	Brick-earth	10
		14

37. Ellingham, Great.—At Crown Inn.†

(Boulder) Clay	37

38. Ellingham, Little.—At Vineyard Farm.†

Glacial Drift	Red clay	2
	White clay	2
	White sand	8
		12

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* Sunk and communicated by Mr. J. Banham, of Shelfhanger.
† „ „ Mr. Pooley, of Besthorpe.

39. Eccles.—By the Station.[*]

	Feet.
Sand	15

40. Fundenhall.—At Cottages near the Hall.[‡]

Sunk 40 feet, bored 30 feet.

(Boulder) Clay	70

To sand, water rose 35 feet.

41. Fundenhall.—Another well close by.[*]

Sunk 30 feet, bored 25 feet.

Black moory soil	55

42. Fundenhall.—At the Hall.[*]

Sunk 50 feet, bored 30 feet.

(Boulder) Clay	80

To sand and water.

43. Fundenhall.—By the Church.[*]

(Boulder) Clay	60

44. Hargham.—The "Sheepwalks."[†]

Sand	6

45. Hargham.—By the Bridge at the four cross roads.[†]

Sand	?
(Boulder) Clay	?

46. Hockham.—In the Village.[†]

Gravel	2
(Boulder) Clay	20
	22

47. Merton.—At the Hall.[‡]

(Boulder) Clay	5
Marl	10
Chalk	100
	115

48.—New Buckenham.—In the Town.[*]

Sand	16

49.—New Buckenham.—Near the Church.[*]

(Boulder) Clay	30

Water rose 20 feet.

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[*] Sunk and communicated by Mr. J. Banham, of Shelfhanger.
[†] ,, ,, Mr. Lincoln, of Attleborough.
[‡] ,, ,, Mr. Pooley, of Besthorpe.

50. OLD BUCKENHAM.—At Mr. Salter's.*

	FEET.
Gravel and sand	10

51. OLD BUCKENHAM.—At the Hall.*

Clay and marl	20

52. OLD BUCKENHAM on the Fen.†

Marl	31
Fenny bottom.	

53. ROCKLAND.—At the Magpie Inn.†

(Boulder) Clay	22
To sand and water.	

54. SPOONER ROW.—At the five cross-roads east of Station.†

(Boulder) Clay	57

55. SPOONER ROW.—At Boar's Corner.†

(Boulder) Clay	47
To sand, water rose 40 feet.	

56. SPOONER ROW.—Near the Boar's Corner.†

(Boulder) Clay	56
White sand	4
Water overflowed.	
	60

57. TACOLNESTON.—At Baker's, by the 11th mile stone.*

Sunk 55 feet, bored 30 feet.

(Boulder) Clay	85
Sand, water rose 45 feet.	

58. TACOLNESTON.—At the Hall cottages.*

Sunk 55 feet, bored 30 feet.

(Boulder) Clay	85
Sand, water rose 80 feet.	

59. TIBBENHAM.—On the Green.*

(Boulder) Clay	25
"Land spring."	

60. TIBBENHAM.—At Mr. Pearson's on the Long Row.*

(Boulder) Clay	20
Sandy at the bottom, water rose 2 feet.	

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* Sunk and communicated by Mr. J. Banham, of Shelfhanger.
† " " Mr. Pooley, of Besthorpe.

61. TIBBENHAM.—At the Almshouses.*

	Feet.
(Boulder) Clay	20

Sandy at the bottom, water rose 2 feet.

62. TIBBENHAM.—At Mr. Fordham's, near the Boot Inn.*

Sunk 50 feet, bored 28 feet.

(Boulder) Clay	78

Sand, water overflowed.

63. TIBBENHAM.—Mr. Lester's, Long Row.*

(Boulder) Clay	45

"Land spring."

64. TIBBENHAM.—Mr. Kett's, Long Row.*

Sunk 45 feet, bored 25 feet.

(Boulder) Clay	70

Sand, water rose 60 feet.

65. TIBBENHAM.—Mr. Self's, Pristow Green.*

Sunk 50 feet, bored 30 feet.

(Boulder) Clay	80

Sand, water rose 70 feet.

66. TIBBENHAM.—By the Church.*

(Boulder) Clay	24

Sand, water rose 2 feet.

67. TIBBENHAM.—At the Greyhound Inn.*

Boulder Clay	20

Sand, water rose 2 feet.

68. TIBBENHAM.—Near the Boot Inn.†

(Boulder) Clay	27

Sand, water rose 10 feet.

69. WINFARTHING.—At the Hall road.*

Sunk 55 feet, bored 25 feet.

(Boulder) Clay	80

Sand, water rose 50 feet.

70. WINFARTHING.—Mr. Bett's, Dovehouse Farm.*

Sunk 35 feet, bored 20 feet.

(Boulder) Clay	55

Sand, water rose 50 feet.

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* Sunk and communicated by Mr. J. Banham, of Shelfhanger.

† „ „ Mr. G. Banham, of Winfarthing.

71. Wymondham.—The last house on the Kimberly Road.*

	Feet.
Sand and gravel	25
Marl	8
	33

72. Wymondham.—At Great Park Farm cottages, two miles south of the Church.*

Sunk 30 feet, bored 25 feet.

Boulder Clay	55
Water overflowed.	

73. Wymondham.—Near the Boar's Inn.*

Clay and sand	20

74. Wymondham.—In Suton Street.

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* Sunk and communicated by Mr. J. Banham, of Shelfhanger.

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